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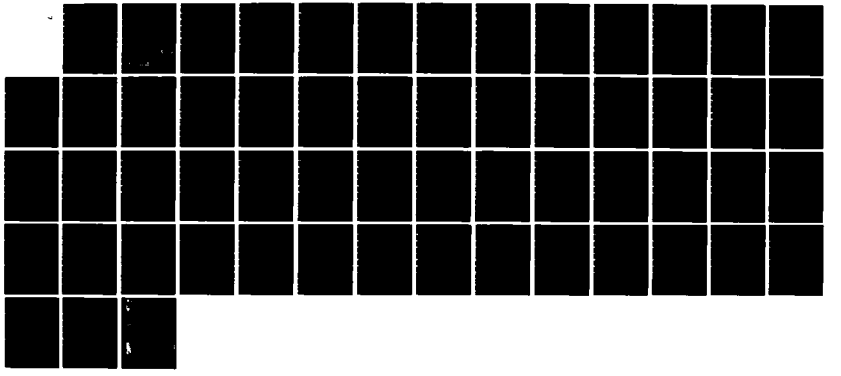

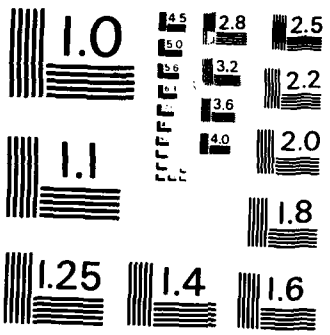

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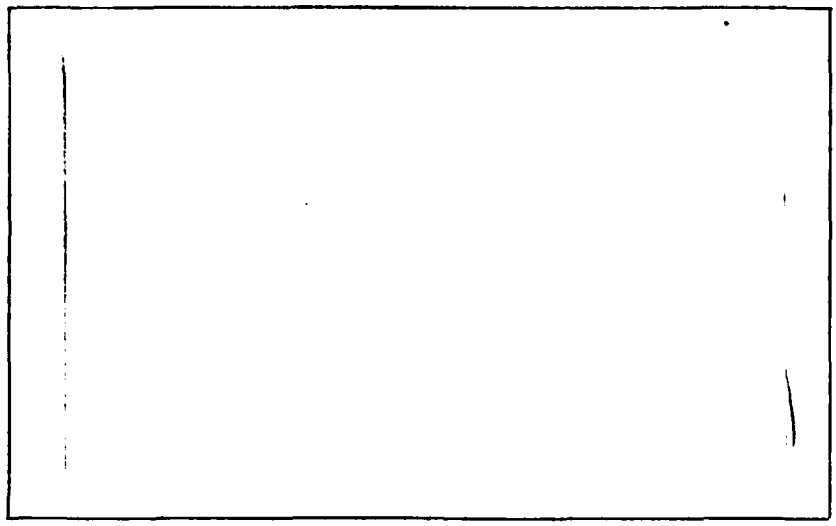

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This is the first volume of a set of reports which document the findings of a study being conducted by Desmatics, Inc. for the Office of VAMOSC, Air Force Logistics Command. This study constitutes an assessment of the cost allocation algorithms employed within the Weapon System Support Cost (WSSC) subsystem of the Air Force Visibility and Management of Operating and Support Costs (VAMOSC) system. The role of Desmatics, Inc. is to evaluate the methods

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and data employed by WSSC to allocate operating and support costs to individual weapon systems.

This volume is devoted to a discussion of the background, objectives and scope of the Desmatics effort. Subsequent volumes in this set of reports provide detailed evaluations of the specific allocation algorithms used within the WSSC system.

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Applied Research in Statistics - Mathematics - Operations Research

AN EVALUATION OF THE WSSC COST ALLOCATION ALGORITHMS

I: OVERVIEW

by

Robert L. Gardner
Dennis E. Smith
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TECHNICAL REPORT NO. 115-2

Original Draft March 1982

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Prepared under Contract No. F33600-80-C-0554

EXECUTIVE SUMMARY

This is the first volume of a set of reports which document the findings of a study being conducted by Desmatics, Inc. for the Office of VAMOSC, Air Force Logistics Command. This study constitutes an assessment of the cost allocation algorithms employed within the Weapon System Support Cost (WSSC) subsystem of the Air Force Visibility and Management of Operating and Support Costs (VAMOSC) system.

The objective of WSSC is to portray the operating and support costs of each major aircraft weapon system in the Air Force inventory. WSSC obtains the majority of its input data from other data systems which provide specially tailored files of cost, manpower, maintenance labor and aircraft flying operations data. Cost data is generally not available by weapon system, making it necessary to allocate shares of common costs to each aircraft on some equitable basis. This allocation of costs is accomplished within WSSC by means of several algorithms which distribute costs using methods appropriate to the type of data available.

The role of Desmatics, Inc. is to evaluate the methods and data employed by WSSC to allocate operating and support costs to individual weapon systems. Specifically, Desmatics' objectives are to appraise the accuracy and appropriateness of WSSC source data and allocation algorithms, to assess satisfaction to user requirements, and, where algorithms are found to have shortcomings, to recommend alternatives.

This volume is devoted to a discussion of the background, objectives and scope of the Desmatics effort, and to consideration of two topics which are pertinent to a number of WSSC algorithms. These are:
(1) an assessment of the allocation logic based on flying hours and

numbers of aircraft (measured in possessed hours), and (2) an evaluation of input data quality. Desmatics' conclusions and recommendations pertinent to these topics are listed in this report, together with accompanying comments from the Office of VAMOSC. Subsequent volumes in this set of reports provide detailed evaluations of the specific allocation algorithms used within the WSSC system.

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I. INTRODUCTION

Desmatics, Inc., under Contract No. F33600-80-C-0554, is conducting an evaluation of the cost allocation algorithms employed in the Weapon System Support Cost (WSSC) subsystem of VAMOSC, the Air Force Visibility and Management of Operating and Support Costs system. This report, the first in a set of several volumes, discusses the background, objectives and scope of the Desmatics technical effort. It also covers two topics common to a number of WSSC algorithms. These are (1) the allocation of costs by algorithms based on flying operations data, and (2) the accuracy of WSSC input data.

The next five volumes, II through VI [3,4,5,6,17], are devoted to assessment of individual algorithms. Volume VII will provide a comprehensive discussion of the findings and recommendations of the overall evaluation, including the results of an ongoing quantitative evaluation. This study, which has an impact on several algorithms, is based on two years' data (FY81 and FY82).

The original draft of this volume was submitted to the Office of VAMOSC in March 1982 for evaluation, as required by the contract statement of work. Later, Desmatics' personnel met with Office of VAMOSC representatives and reviewed this document with respect to both form and content. It was mutually agreed that it would be beneficial to adopt a revised format which somewhat resembles that employed for reports published by the AF Audit Agency in which the organization whose system is being evaluated ("management") is afforded an opportunity to respond and to include its responses in the same report.

This revision, which uses a modified Audit Agency format, also

reflects a number of expansions and phrasing changes initiated by Desmatics to help clarify its findings and recommendations. The Office of VAMOSC subsequently added sections in which it sets forth its response to Desmatics' major recommendations. This format and procedure will be adopted for all volumes in this series of deliverables.

The Statement of Work under which this Desmatics study was initiated calls for the evaluation of the WSSC system algorithms as set forth in system specifications dated June 1980. The WSSC system has evolved almost continually since that time, reflecting inprovements that were made in virtually every aspect of the system logic prior to the first production run in April 1982. Additional modifications and enhancements were made to WSSC between the first production run in 1982 and the second run made in April 1983, and more are planned for the immediate future.

Desmatics recognizes that to restrict its evaluation to the June 1980 baseline would significantly limit the usefulness of its findings. Accordingly, Desmatics has kept pace with the evolution of the WSSC system, and has attempted to reflect the significant system changes in its study, specifically in those instances where a given cost was computed by different algorithms in two (or more) years. As a result, the documentation of Desmatics' findings is more complex than might otherwise be the case. The reader may expect frequent encounters with the phrases "for FY81," "for FY82" and "for FY83."

Desmatics has endeavored to have this volume reflect the current status of the WSSC system. The authors feel that this has been accomplished. However, the reader must realize that should future WSSC system changes impact on the algorithms discussed, portions of this report may become outdated.

II. BACKGROUND

Department of Defense Management by Objective MBO 9-2 [2] established the need for each service to provide the means for identifying the operating and support (O&S) costs of its major weapon systems. The Cost Analysis Improvement Group (CAIG) within the Office of the Secretary of Defense has established a set of guidelines [1] for use by cost analysts in preparing cost estimates for aircraft weapon systems. These guidelines additionally provide definitions of the cost categories of interest.

The vehicle for accomplishing DOD objectives is referred to as Visibility and Management of Operating and Support Costs (VAMOSC). The mechanism evolved within the U.S. Air Force to satisfy its own internal requirements for cost visibility as well as those of DOD is the VAMOSC program [13], a comprehensive management information system composed of three major modules:

(1) WSSC (Weapon System Support Cost) [14], which gathers, computes and displays costs for aircraft;

(2) C-E (Communications-Electronics) [15] which provides costs for ground C-E equipment;

and (3) CSCS (Component Support Cost System) [16] which identifies maintenance costs at the subsystem and component level.

The data system designators for these three systems are D160, D160A and D160B respectively. Another module, called VAMOH [8], provides preprocessor services to the WSSC and C-E modules.

The WSSC module of the Air Force VAMOSC system evolved from the Operating and Support Cost Estimating Reference (OSCER) system which was initially designed and placed in operation in the mid-1970's. WSSC is designed to provide various users with annual dollar amounts of the costs incurred in operating and supporting each Air Force major aircraft

weapon system during the preceding fiscal year. Operating and support costs are aggregated at various levels, but the principal requirement is for these costs to be identified by weapon system mission-design-series (MDS). WSSC provides the required MDS breakdown through a system of cost allocation algorithms which distribute various categories of aggregated O&S costs to each MDS in proportion to the distribution of a pertinent variable or combination of variables.

The structure of the WSSC module is oriented primarily toward production of two standard annual reports (with the capability to produce special reports tailored to user requirements). One of these is referred to as the USAF Detail format report and the other as the CAIG format report. They contain essentially the same information, but are displayed in different formats to meet user requirements.

Aircraft O&S costs have been divided into thirteen major cost categories for display in the USAF Detail report. The following list of these categories provides an indication of the types of costs included in WSSC:

1. Unit Operations
2. Below Depot Maintenance
3. Installation Support
4. Sustaining Investment
5. Depot Maintenance
6. General Depot Support
7. Second Destination Transportation
8. Depot Installation Support
9. Advanced Flying Training
10. Advanced Training

11. Medical Care

12. Permanent Change of Station

13. Personnel Replacement

It is not meant to imply that WSSC processing programs map directly, one-to-one, with these thirteen categories, or that these constitute the only categories of costs displayed by the WSSC system. In actuality, many of these major categories are further divided into subcategories. For example, unit operations consist of aircrew, command staff, security, POL, training munitions, and other unit personnel costs. There were 38 cost categories provided in the FY81 USAF Detail report format. However, for FY81 only 29 types of costs were actually reported, because the algorithms for second destination transportation, advanced flying training, advanced training, permanent change of station and personnel replacement were not implemented for that fiscal year.

The output of the WSSC module of VAMOSC is a display, by MDS, of the personnel strengths assigned and the costs expended to operate and support each aircraft weapon system. It should be emphasized that WSSC is designed to display costs actually incurred and personnel actually employed; WSSC is not a cost estimation system, nor is it a budgeting system.

WSSC receives input from the six data processing systems listed in Figure 1. Under Memorandums of Agreement, each of these systems provides an extract of data required by WSSC in a specified format, according to an agreed-upon time schedule. A few of the data systems collect and report some types of O&S costs by MDS. However, in many instances it is necessary for WSSC to allocate not only the typical "overhead" types of costs, but also, in some cases, direct costs which the input data

DATA SYSTEM DESIGNATOR	COMMON NAME	DESCRIPTION
D022A	AVFUEL	Centralized Fuels Management System
E300Z	MPC	Advanced Personnel Data System
E506	AMMIS	Aerospace Maintenance Manpower Information System
G033B	AVISURS	Aerospace Vehicle Inventory Status/ Utilization Reporting System
H036C	WSCRS	Weapon Systems Cost Retrieval System
H069R	ABDS	Standard Major Command Level Accounting and Budget Distribution System

Figure 1: Data Systems Providing Input Used in FY81 By the WSSC and VAMOH Modules of VAMOSC

systems do not identify by MDS.

The allocation of aggregated costs to specific MDS levels within WSSC is accomplished using what is sometimes referred to by cost accountants as a set of "charging rates". Charging rates are usually based on some measurable quantity which is thought to relate either to the amount of service provided, the amount of service consumed or the costs actually incurred, but not known directly. In WSSC four general types of data are used to distribute costs: (a) strength ratios, based on the number of personnel assigned to aircraft operations; (b) a composite measure based on aircraft flying hours (a measure of activity) and possessed hours (a measure of aircraft inventory); (c) reported maintenance direct labor hours; and (d) estimated average cost factors (e.g., annual medical care costs per person).

The reports produced by WSSC are vital input to the DSARC process, and serve as an important management tool throughout the Air Force for providing visibility of weapon system operating and support costs. The extent to which WSSC cost outputs are satisfactory for their intended purpose depends primarily on two factors:

(1) the quality of data extracted from other systems (WSSC input),

and (2) the validity and efficiency of the internal algorithms which perform the cost allocation processes.

Recognizing the importance of accuracy and validity in WSSC's products, the Air Force has contracted with Desmatics, Inc. to perform an independent evaluation of the input data and of the allocation methodologies used in the WSSC system.

III. STUDY SCOPE

The purpose of the Desmatics study is to perform a detailed evaluation of the WSSC module of the Air Force VAMOSC system. More specifically, the study has five objectives:

(1) to appraise the accuracy and appropriateness of source data;

(2) to evaluate the accuracy and appropriateness of algorithms;

(3) to determine satisfaction of CAIG requirements;

(4) to develop alternative algorithms (if required);

and (5) to prepare technical documentation of the study's conclusions.

In essence, this investigation involves what is often referred to as validation, determining whether the products of the WSSC system are in some sense true, meaningful, fair and correctly derived. As applied here, validation involves critical examination of the logic of the algorithms used in WSSC. A previous Desmatics report [11], discusses general guidelines for validation of cost allocation methodologies.

A. AN OVERVIEW

It should be noted that the WSSC system performs three distinct types of operations: selection, classification and allocation. The system starts with a broad spectrum of available data representing incurred costs. It selects those costs deemed to be pertinent to aircraft operation and support, classifies certain of them within a structure of cost categories, and then allocates shares of the costs to specific types of aircraft. In a narrow sense, the algorithms may be defined as those rules and procedures used in the allocation processes.

However, in a broader sense the procedures used in selecting and classifying elements of cost are also significant parts of the system's algorithms. Thus, not only is it necessary to assess the validity of the processes by which WSSC allocates shares of each cost category to types of aircraft, but also to evaluate the procedures by which costs are selected and assigned to categories, including the way that WSSC uses the codes present in the data (e.g., PEC, RC/CC, EEIC, FAC) to select records for input.

It is also necessary to determine whether the data base can be improved. Perhaps some part of the data base currently used in cost allocation could be replaced by a different data base which would permit allocation at a lower, more detailed level. Although the data base really does not form a part of any allocation algorithm, a good algorithm can be useless if it is based on inaccurate data or if the algorithm was designed with respect to assumed and sometimes idealistic characteristics of the data base which are not realized in practice. Thus, some assessment must be made of current data source accuracy so that management can judge the need for finding alternative sources or developing new ones.

There are many cost categories which WSSC must consider. For each cost category, the total expenditures over all MDS's are available as WSSC input. These total expenditures must be apportioned to each MDS, often by means of an allocation algorithm. One example is the installation support costs (materiel, contract and labor) for a base. The purpose of the type of validation effort considered here is to examine the algorithms used to allocate the costs to each MDS to insure that costs are allocated consistently and fairly among all MDS's.

If C_{ij} denotes the amount in cost category j allocated by WSSC to

MDS i, the validation task has as its objective the comparison of C_{ij} with T_{ij}, the corresponding "true" costs. Because there are a number (K) of MDS's and each of N cost categories, the overall task is to compare the matrix $\underline{C}$ with the N x K matrix $\underline{T}$. This is illustrated in Figure 2. However, in most cases, the actual costs that should be assigned to a given MDS are not known. For the most part, the existing cost data is pooled over a number of activities or, at least, over a number of MDS's. Thus, direct validation by examination of the differences between the WSSC allocation cost matrix $\underline{C}$ and the true cost matrix $\underline{T}$ is seldom possible, since most of the entries in the latter matrix correspond to unknown values. Instead, the validation effort must take an indirect route. Such indirect validation is concerned with two general types of validity. One, face validity, involves a qualitative assessment, while the other, mathematical validity, involves a quantitative assessment. A Desmatics technical report [9], based on a presentation given at the 17th Annual DOD Cost Analysis Symposium provides a general discussion of the overall validation problem.

B. FACE VALIDITY AND MATHEMATICAL VALIDITY

Face validity refers to the examination of the algorithms on a subjective, common-sense basis. In examining face validity, one must ask whether the allocation algorithms appear reasonable, particularly when compared to possible alternative allocation schemes, and whether the algorithms appear to provide equitable results, e.g., whether the choice of an allocation basis is fair, and does not make one group of MDS's bear an inordinate amount of the costs.

Parallel with the consideration of face validity, it is necessary

- TWO MATRICES :

$$\underline{C} = \begin{bmatrix} C_{11} \cdots C_{1K} \\ \vdots \quad\quad \vdots \\ C_{N1} \cdots C_{NK} \end{bmatrix} \qquad \underline{T} = \begin{bmatrix} T_{11} \cdots T_{1K} \\ \vdots \quad\quad \vdots \\ T_{N1} \cdots T_{NK} \end{bmatrix}$$

C_{ij} – COSTS IN CATEGORY i ALLOCATED BY WSSC TO MDS j

T_{ij} – "TRUE" COSTS OF MDS j WITHIN CATEGORY i

- OBJECTIVE IS TO COMPARE $\underline{C}$ AGAINST $\underline{T}$

Figure 2: An Illustration of the Validation Task

to consider algorithms from a quantitative standpoint. This involves the concept of mathematical validity, which refers to the quantitative evaluation of the mathematical framework underlying the cost allocation algorithms. As part of this type of validation, the algorithms are examined to insure that they produce consistent results.

Assessing the mathematical validity of WSSC algorithms requires development of appropriate analysis techniques, collection of necessary data, and application of the techniques to the data. Data appropriate for such an analysis is available as a by-product of production runs of the VAMOSC system. As a consequence, this volume, and the next five volumes which follow, are devoted mainly to qualitative evaluation (i.e., face validity) of the WSSC system as it was configured to produce FY81 and FY82 outputs. The more quantitative evaluation of WSSC algorithms will be documented in Volume VII, scheduled for publication later in the WSSC system development cycle.

IV. ASSESSMENT OF ALLOCATION BASED ON FLYING OPERATIONS

The logic of many of the WSSC processes is based on the assumption that flying hours (FH) and possessed hours (PH) are appropriate variables for use in allocation of many of the costs to the various MDS's. Although this is a reasonable assumption, the algorithms developed using these variables are constructed in such a manner that the resulting allocations are inconsistent. A relatively simple change in the algorithms, and hence to the program logic can overcome this inconsistency. The following sections discuss aspects of the current WSSC flying operations ratio, how it is inconsistent, and recommended modifications.

A. CURRENT WSSC ALLOCATION

The flying operations ratio used most often in the WSSC algorithms may be represented as:

$$.5\ (FH/\Sigma FH + PH/\Sigma PH). \qquad (1)$$

Although (1) is referred to in the WSSC documentation [3] as a ratio, it is really the average of two ratios. In any case, it is a particular instance of the more general weighted average

$$p(FH/\Sigma FH) + (1-p)(PH/\Sigma PH) \qquad (2)$$

where $0 \leq p \leq 1$. Specifically, the value of $p = 0.5$ is used in WSSC for most cases involving flying hours and possessed hours as the bases of allocation. However, for POL a value of $p = 1.0$ (allocation based only on flying hours) is used, while for Mod Kits, a subcategory of Sustaining Investment, a value of $p = 0.0$ (allocation based only on possessed hours) is used. Throughout all applications of this type of ratio or

weighted average, the numerator identifies a unique MDS/command/base combination. The denominators, however, vary depending upon the level of aggregation of the costs being allocated. Figure 3 defines the denominators for each of the cost categories for which weighted average (2) is currently used.

WSSC documentation does not include an explanation of the rationale for this general type of weighted average, nor for the particular choice of $p = 0.5$, which was used extensively for FY81 computation. Apparently, however, it was selected because it gave the flying hour and the possessed hour proportions equal weight in the allocation process. The intent may be inferred that MDS's should bear a share of total costs in proportion to their relative levels of flying activity (measured by flying hours) and/or fleet size (measured by possessed hours). For FY81 the flying and possessed hour proportions were averaged, giving them (the proportions) equal weight in determining the MDS share of the total cost. The problem with this approach is that the relationship between the MDS's is influenced by the presence of other MDS's. (Based in part on recommendations from Desmatics, the flying operations ratios will be replaced. In general, the corresponding allocations will instead be based on relative personnel strengths. Therefore, the problem of flying operations ratios has largely become moot for WSSC production after FY81.)

B. INCONSISTENCY OF THE ALLOCATION RATIO

One major characteristic any allocation algorithm should posses is consistency. That is, once parameters such as flying hours and possessed hours are selected for use in allocation of costs within a given category, they should be incorporated into an algorithm in such a way that

	ΣFH, ΣPH Denominator	Assigned Value of p
Command Staff	M,c,b	0.5
Other Unit Costs	M,c,b	0.5
Medical	M,c,b	0.5
*POL	m,A,B	1.0 (Flying hours only)
*Sustaining Investment		
Replacement Spares	m,A,B	0.5
Mod Kits	m,A,B	0.0 (Possessed hours only)
*Depot Maintenance	m,A,B	0.5
General Depot Support	M,A,B	0.5
Depot Installation Support	M,A,B	0.5
Installation Support	M,C,b	0.5
Security	S,c,b	0.5

m = unique MDS

c = unique relevant command

b = unique base

M = all MDS's

C = all relevant commands (AAC, AFE, ATC, MAC, PAC, SAC, TAC)

B = all bases

S = all MDS's requiring security

A = all commands

* For a discussion of these two-step allocation algorithms, see Section D.

Figure 3: Definitions for Denominators for the WSSC Flying Operations Ratio by Cost Categories

comparisons between two MDS's are not dependent on the parameter values associated with another MDS. In other words, the relationship between two MDS's should remain stable.

For example, consider an allocation of costs to three MDS's at a particular base, using the ratio (1) currently in WSSC. Based on illustrative data in Figure 4, the algorithm allocated $7,500 both to MDS#1 and MDS#2. In order for the algorithm to be consistent, the amounts allocated to these two MDS's should always be in the same ratio (in this example one-to-one), independent of the third MDS, so long as the flying and possessed hours of MDS#1 and MDS #2 do not change. However, as can be seen from Figure 5, the ratio of costs allocated to MDS#1 relative to MDS#2 varies, in this example, from 0.80 to 1.17 depending upon the flying and possessed hours of MDS#3. Thus, the current allocation algorithm is inconsistent.

C. A RELATED CONSISTENT RATIO

Assuming that an allocation ratio which gives equal weight to flying hours and possessed hours is to be used, then the appropriate ratio, a consistent version of (1), is

$$(FH + PH) / \Sigma(FH + PH). \qquad (3)$$

A more general ratio, which gives each flying hour r times the weight of a possessed hour, is

$$(rFH + PH) / \Sigma(rFH + PH) \qquad (4)$$

The primary implication here is that if flying and possessed hours are to be used as allocation parameters, the inconsistency of ratio (1) renders the associated algorithm invalid. The use of ratio (4) will, however, provide a consistent algorithm using the same allocation

Total Costs to be Allocated: $20,000

	Flying Hours (FH)	FH/ΣFH Ratio	Possessed Hours (PH)	PH/ΣPH Ratio	Allocated Costs
MDS#1	200	.50	1,000	.25	$ 7,500
MDS#2	100	.25	2,000	.50	7,500
MDS#3	100	.25	1,000	.25	5,000
Totals	400 (ΣFH)	1.00	4,000 (ΣPH)	1.00	$20,000

MDS#1 is allocated $20,000[.5(.50 + .25)] = $7,500.

Allocations for MDS#2 and #3 are made similarly.

Figure 4: Illustrative Data for WSSC Allocation

Total Costs to be Allocated: $20,000

	Flying Hours	Possessed Hours	Ratio (1) Allocated Costs	
MDS#1	200	1,000	$ 7,500	R = 1.00
MDS#2	100	2,000	7,500	
MDS#3	100	1,000	5,000	
TOTALS	400	4,000	$20,000	

Total Costs to be Allocated: $30,000

MDS#1	200	1,000	$ 6,000	R = 0.80
MDS#2	100	2,000	7,500	
MDS#3	700	2,000	16,500	
TOTALS	1,000	5,000	$30,000	

Total Costs to be Allocated: $40,000

MDS#1	200	1,000	$10,500	R = 1.17
MDS#2	100	2,000	9,000	
MDS#3	200	5,000	20,500	
TOTALS	500	8,000	$40,000	

R denotes ratio of MDS#1 allocated costs to MDS#2 allocated costs using existing WSSC allocation ratio (1).

Figure 5: Cost Allocations Indicating the Inconsistency of the Flying Operations Ratio

parameters.

Another parameterization of ratio (4) is

$$[pFH + (1-p)PH]/[p\Sigma FH + (1-p)\Sigma PH] \qquad (5)$$

where the relationship between p and r is given by

$$r = p/(1-p)$$

or, equivalently, by

$$p = r/(1+r).$$

There are a number of similarities between the general form of the current allocation ratio (2) and the related consistent ratio, as can be seen by examining (2) and (5). For each, the parameter p may take on the values $0 \leq p \leq 1$. Both ratios are completely insensitive to the value of p if and only if flying hours are proportional to possessed hours. Furthermore, for both ratios, p = 0.0 implies allocation based solely on PH while p = 1.0 implies allocation based solely on FH.

In those cases where this type of allocation is judged appropriate, just what value of r (or, equivalently, p) is to be recommended is an open question. Of course, the choice of equal weighting of flying hours and possessed hours (r = 1.0) might be made, but such a choice would have no more justification than the selection of p = 0.5 for use in the existing WSSC allocation ratios. However, a major point is that the consistent ratio, no matter which value of r is selected, will not suffer from the inconsistency of the ratio currently being used. Section E discusses the problem of determining the best value of p (or r).

D. THE RELEVANT/ALL RATIOS

As described in the WSSC Subsystem Specification [7], the costs for

Modification Kits (a part of Sustaining Investment), Depot Maintenance, and POL are allocated in a two-stage operation. In these cases, costs are identified as service-wide costs for an MDS. Total costs for each MDS are first preallocated using a ratio of flying operations data for all relevant commands to all commands worldwide to determine the portion of the total cost of an MDS which should be borne by relevant command aircraft. These amounts are then apportioned among the relevant command-base combinations using other flying operations ratios.

It would seem reasonable to assume that equivalent allocations for these categories could be done in a single step rather than in two. In fact, the WSSC Users Manual (AFR 400-31, Vol. II) [14] implies this to be the case. However, it can be verified that the one-step and two-step methods give different results when the flying operations ratios currently described in WSSC documentation are employed.

As an illustration of the discrepancy, Figure 6 shows a comparison of the results obtained for a highly simplified hypothetical example, based in part of real FY81 data for one MDS at five bases within two commands. It is assumed that a total of $71,000 K was spent on all aspects of depot maintenance for the C5A in FY81. The task is to allocate portions to the three MAC bases. In the two-step method the first step is to develop a relevant/all ratio showing the proportion of total worldwide C5A flying performed by MAC. The second step allocates the MAC share among the three bases. In the one-step algorithm the costs are allocated by calculating each base's share of the worldwide C5A flying.

The difference in this example between the two methods is relatively small (about 4%). However, is is not simply rounding errors but the result of using a method of weighting flying hours relative to possessed

HYPOTHETICAL C5A FLYING DATA

CMD	BASE	PH		FH	
MAC	A	60,000		13,000	
	B	180,000		15,600	
	C	180,000		18,200	
TOTALS:			420,000		46,800
LOG	D	60,000		1,820	
	E	120,000		3,380	
TOTALS:			180,000		5,200
WORLDWIDE TOTALS:			600,000		52,000

ALLOCATION OF HYPOTHETICAL $71,000,000
C5A DEPOT MAINTENANCE COST TO BASE "A"

Two-Stage:

$$\text{Relevant/All Ratio} = 0.5 \left[\frac{420,000}{600,000} + \frac{46,800}{52,000} \right] = .800000$$

$$\text{Base "A" Flying Operations Ratio} = 0.5 \left[\frac{60,000}{420,000} + \frac{13,000}{46,800} \right] = .210317$$

Depot Maintenance Cost = $71,000 K x .800000 x .210317 = $11,946 K

One-Stage:

$$\text{Depot Maintenance Cost} = \$71,000\,K \times 0.5 \left[\frac{60,000}{600,000} + \frac{13,000}{52,000} \right] = \$12,425\,K$$

Figure 6: Comparison of One-Stage and Two-Stage Allocation of Depot Maintenance Costs Using the Current WSSC Flying Operations Ratio

hours which does not produce consistent results. When such a weighting technique is employed using the consistent ratio given in Section C, identical results are achieved in a one-step calculation and in a two-step calculation. Figure 7 provides an illustration of this using consistent ratio (4) with r = 5.0 (that is, with a flying hour weighted five times as much as a possessed hour).

E. QUANTITATIVE EVALUATION FRAMEWORK

As previously discussed, the WSSC allocation algorithms based on flying operations data are inconsistent. Because of this, further consideration of the algorithms will be focused on their consistent counterparts, which are of the form given by (4) or (5). As the weight shifts in these ratios from PH only (p = 0.0) to FH only (p = 1.0), the corresponding allocation ratio shifts from PH/ΣPH to FH/ΣFH. Thus, the difference in the allocations provided by these two ratios provides a measure of the sensitivity of the cost allocations to changes in the value of p over the range (0,1).

Although a sensitivity analysis can help identify those MDS's or processes which are most sensitive to a selected value of p, it does not provide any means of assessing the validity of using that value in the algorithms. However, such an assessment can be made based on AVISURS and ABDS data.

The consistent ratio, as parameterized in (5), indicates that for a given cost category, the cost allocated to an MDS is proportional to pFH + (1-p)PH, for whatever value of p is chosen. As an illustration, for a given MDS let y_1 denote the total FY81 costs to be allocated for

ALLOCATION OF HYPOTHETICAL $71,000,000
C5A DEPOT MAINTENANCE COST TO BASE "A"

Two-Stage:

$$\text{Relevant/All Ratio} = \frac{420,000 + 46,800(5)}{600,000 + 52,000(5)} = 0.760465$$

$$\text{Base Flying Operations Ratio} = \frac{60,000 + 13,000(5)}{420,000 + 46,800(5)} = 0.191132$$

$$\text{Depot Maintenance Cost} = \$71,000\,K \times .760465 \times .191132 = \$10,320\,K$$

One-Stage:

$$\text{Depot Maintenance Cost} = \$71,000\,K \times \left[\frac{60,000 + 13,000(5)}{600,000 + 52,000(5)}\right] = \$10,320\,K$$

Figure 7: Comparison of One-Stage and Two Stage Allocation of Depot Maintenance Costs Using a Consistent Flying Operations Ratio with r = 5.0.

a particular cost category and let y_2 denote the corresponding total FY82 costs. Denote the total flying hours and possessed hours for that MDS in FY81 by ΣFH_1 and ΣPH_1 and FY82 by ΣFH_2 and ΣPH_2.

Under the assumption underlying the allocation, y_1 is proportional to $p\Sigma FH_1 + (1-p)\Sigma PH_1$, with an equivalent proportionality holding for y_2. This proportionality can be made into equalities by using an unknown constant c. That is,

$$y_1 = c[p\Sigma FH_1 + (1-p)\Sigma PH_1]$$

and (6)

$$y_2 = c[p\Sigma FH_2 + (1-p)\Sigma PH_2].$$

This set of equations may be rewritten as a type of regression model

$$y = Ax + Bz$$

where

$$A = cp$$

$$B = c(1-p)$$

$$x = \Sigma FH$$

and $$z = \Sigma PH.$$

There are three major assumptions in postulating this regression framework. These are:

(1) y denotes marginal variable costs (i.e., if x = z = 0, then y = 0).

(2) y is in constant dollars (i.e., a correction for inflation has been made).

(3) Although the relationship y = Ax + Bz will not necessarily hold exactly because of statistical variation, the observed values of y will fluctuate from year-to-year around Ax + Bz.

With two years of AVISURS and ABDS data, the values of A and B may be obtained by solving the corresponding equations. These values may, in turn, be used to obtain the value of p from the equality

$$p = A/(A + B). \quad (7)$$

It is best to denote this value of p by $\hat{p}$, since it is, after all, only an estimate of the true value of p (assuming, of course, that the algorithm is correct). If for example, a third year's data were available, an estimate of p would have had to be obtained as a least-squares solution. Thus, just because equations (6) can be solved exactly for p, it does not mean that the solution is the true value of p. However, if the allocation algorithm were valid, it would be expected that the value obtained from (7) would be close to that value.

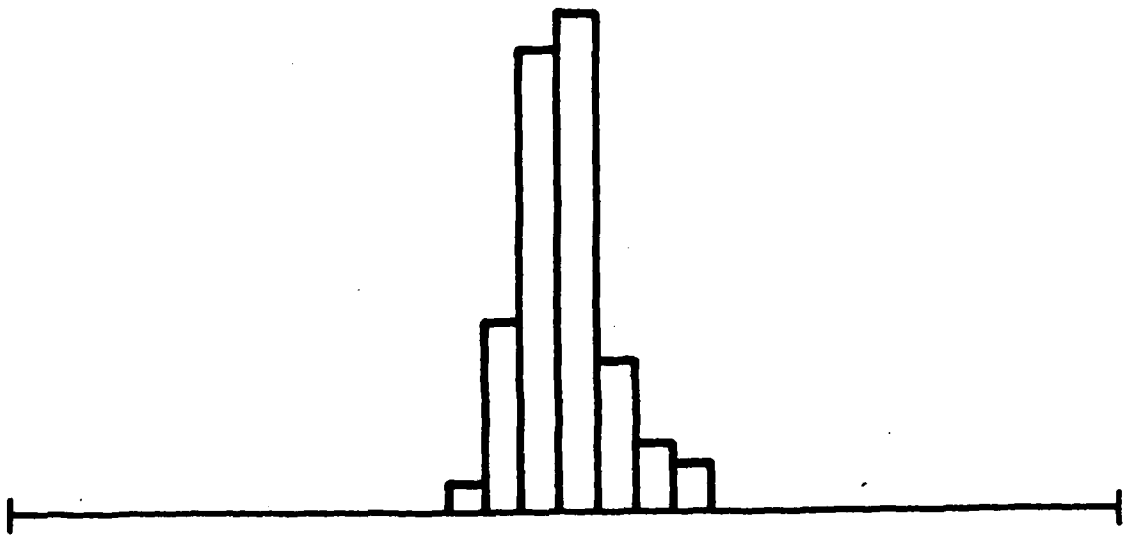
It should be noted that a separate value of p will be obtained for each MDS by solving (6) for the data corresponding to that MDS. If the algorithm is correct, the observed p's should cluster about a single value. Figure 8 provides an illustration of two possible results: one which would, and one which would not, support the validity of the general allocation algorithm for the cost category considered. A quantitative evaluation of this validity will be made by examining the FY81 and FY82 data for the existence of subpopulations, based on likelihood ratio tests.

This approach will work well with most cost categories that have allocations based on flying operations data. The exceptions are Depot Installation Support and General Depot Support, both of which would provide only one estimate $\hat{p}$ each. Nonetheless, the estimated value would still provide some information.

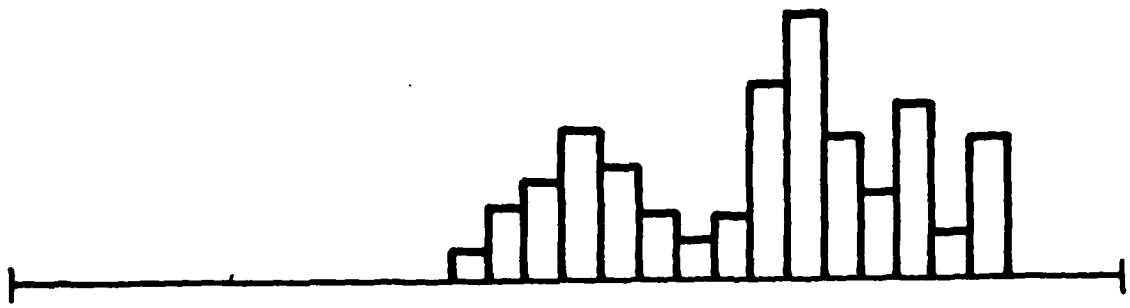
The cost categories within other processes would provide a reasonable data sample on which to base the statistical tests. Specifically, the following number of observations would result:

(1) Installation Support - one observation per base

(2) Command Staff - one observation per CMD/base



0 Observed values of p supporting the validity of the general allocation algorithm



0 Observed values of p not supporting the validity of the general allocation algorithm

Figure 8: Illustration of Results Relative to the Validity of the General Allocation Algorithm for a Cost Category

(3) Security - one observation per CMD/base

(4) Medical - one observation per CMD/base

(5) POL - one observation per MDS

(6) Sustaining Investment - one observation per MDS

(7) Depot Maintenance - one observation per MDS

Once the required ABDS and AVISURS data from FY81 and FY82 is available, a quantitative assessment of the flying operations ratios will be made for each cost category in which allocations are based on this type of ratio.

It should be noted that for POL, WSSC allocation is based on flying hours only. The choice of FH as the only basis for allocation is intuitively reasonable: the number of hours flown is a significant cost driver for POL. Novetheless, the POL cost category would also be examined in the quantitative framework to provide a pseudo-normative case. That is, it would be expected that if the general allocation ratio involving both PH and FH were used for POL, the estimates of p obtained should all cluster near 1.0. A similar condition exists for Sustaining Investment Mod Kits, where it would be expected that the estimates of p should cluster near 0.0.

For FY81 processing, WSSC used a weighted flying operations ratio (i.e., based on both PH and FH) for the allocation of system security costs. However, for FY82 and beyond this allocation has been changed to use only PH ratios as the basis for allocation of security costs. This implies, of course, that one would expect the corresponding values of p to be near 0.0.

V. ASSESSMENT OF WSSC INPUT DATA

The quality of the data used by WSSC can have a significant impact on WSSC output. Because of this, an assessment has been made of input data quality and its potential effect on system products. This section provides a general discussion; additional topics more specific to a particular algorithm are addressed in the following volumes.

WSSC obtains data primarily from the six data systems listed in Figure 1. The H069R, D022A and H036C systems provide various types of aggregated costs, the E300Z supplies work load distribution data, while the G033B and E506 systems are used to obtain data by which costs are allocated. An extensive independent field sampling of data from these sources has not been made, since the current Desmatics effort is actually Phase I of a comprehensive study planned by the Office of VAMOSC. Phases II and III will examine WSSC inputs in greater detail. (These phases, which are discussed in [9], are summarized in Figure 9.) In the interim, Phase I assessment has placed primary reliance on a review of audits conducted by the AF Audit Agency. In addition, some restricted samples of FY81 AVISURS, MCS, ABDS and MPC data have been analyzed to observe field usage of various code combinations.

When considered in the context of the processing logic employed by VAMOH and WSSC programs as described in the respective system specifications, Desmatics' assessment indicates that there are some types of data which the system might not handle in the best way. In some instances the system would probably include items which should be omitted (and vice versa), while in other situations items would be classified in incorrect or suboptimal ways. Some of these data quality problems are

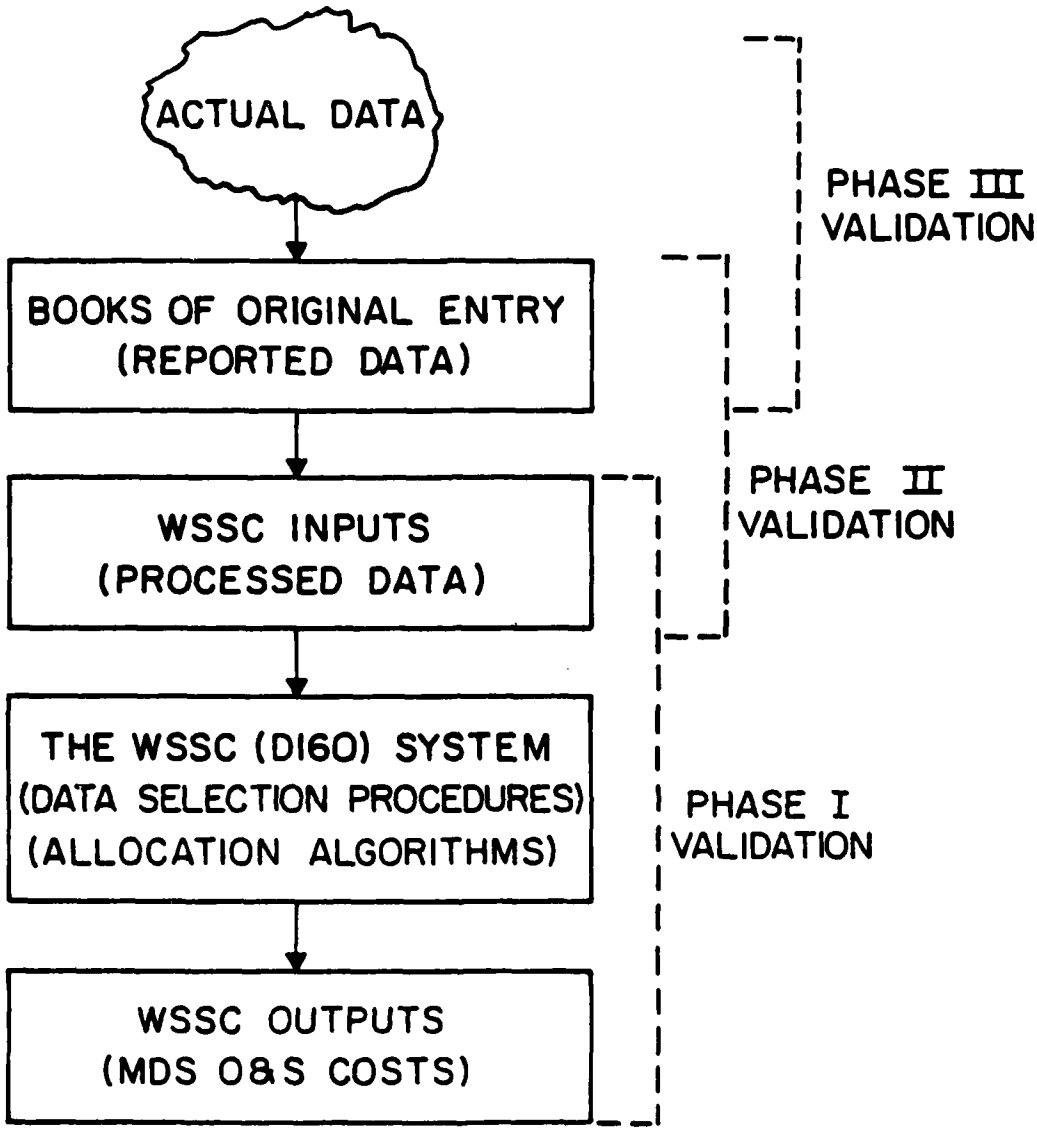


Figure 9: The Three-Phase WSSC Validation Study

discussed in the sections which follow.

A. SURVEY OF AIR FORCE AUDIT AGENCY REPORTS

The Air Force Audit Agency was asked to provide copies of any reports of audits conducted with respect to the six systems used as input sources by WSSC, or any feeders to these systems. In response to this request the Audit Agency sent reports of fourteen audits which it had conducted.

The fourteen reports received were examined to determine their pertinence in evaluating the quality of data obtainable from the systems used by WSSC as sources of cost, manpower and flying data. Eight of these reports were judged not pertinent because they were not concerned with data systems being used as input to WSSC, for example, the MAC Management of Ground Fuels. Five other reports were judged to be only marginally pertinent because, although they concerned data sources used directly or indirectly as input to WSSC, the major concerns of these audits were with aspects of the system not central to WSSC requirements. (For example, an audit of the Advanced Personnel Data System for Officers in 1978 was primarily concerned with the accuracy of career information in individual officer records.)

Thus of the fourteen audit reports received only one, a 1978 evaluation of the AVISURS, provided any indication of the quality of data input to WSSC. This report listed several AVISURS discrepancies, including unmatched inventory gain/loss transactions; disagreements between utilization transaction records and source documents; discrepancies between AVISURS and operations records as to the number of

accumulated flying hours and sorties flown; improper reporting of aircraft owned by one command and loaned to another; and lost, misrouted or misidentified data transmissions from bases to MAJCOMS. In defense of AVISURS it should be pointed out that the field work for this audit was conducted early in 1977 when the AVISURS system was quite new and had not had time to stabilize. Since that audit was conducted, the system managers have made several improvements which presumably have corrected the discrepancies listed in the audit report.

B. OBSERVED AVISURS DATA QUALITY

Desmatics has been provided with tapes of AVISURS data for use in studying the WSSC allocation algorithms. As a result of working with these tapes it is possible to make some observations concerning the current quality of AVISURS data. Two types of AVISURS files were provided, a year-end summary for FY80 containing 1674 records, and 15 monthly tapes (12 for FY81 and three for FY82) each containing 32,000 to 35,000 records. Based on a sampling of the monthly tapes, it was observed that the technical quality of the data appears to be quite high. However, there were a number of instances in which flying hours were reported for an MDS, but no corresponding possessed hours were reported.

These discrepancies might be explained in monthly files as being individual aircraft for which the possessed hour data was late in being reported. However, it was also found that there were several cases in the FY 80 year-end AVISURS data which had reported flying hours but no possessed hours. Since annual data is rolled up over tails, these cases represent situations in which possibly more than one aircraft is

involved. A total of 24 records contained about 250 flying hours with zero possessed hours. Most appeared to be isolated instances in non-standard situations, such as F-16's in foreign countries, or single aircraft in Systems Command or Logistics Command. Since less than one flying hour was in a relevant command, the direct impact of these discrepancies on WSSC allocations should be small.

C. SUMMARY OF DESMATICS MDC STUDY

In 1978, under contract MDA903-78-C-0234 for AF/ACMCA, Desmatics conducted a field investigation designed to demonstrate the feasibility of quantifying the accuracy of reported base-level maintenance direct labor hour (DLH) data [10]. Desmatics observers noted the crew size and start/stop times for a total of 119 maintenance jobs performed at two TAC fighter bases. The Maintenance Data Collection (MDC) system records were then carefully searched at base level in an attempt to locate the information reported for each of these 119 maintenance jobs. Despite diligent efforts, over half the jobs could not be identified in the base-level MDC files for these two bases, even after searching through three months of data. Of the jobs for which matching data could be located, it was found that there was a consistent tendency for inflation in the number of manhours reported by the maintenance personnel compared with the manhours recorded by the Desmatics observers. In fact, on the average about twice as many manhours were reported as Desmatics observed. Differences between bases were not statistically significant.

Based on the Desmatics MDC study, it might be erroneously concluded that maintenance manhour data is too unreliable for use by WSSC. This is

not the case. First, the sample size was too small to support such a blanket conclusion. Second, the study revealed no evidence of bias in DLH reporting errors. If, in fact, DLH reporting errors are unbiased (i.e., if the magnitude and direction of DLH reporting errors are consistent over all work centers, commands and bases), then there is little risk in WSSC using the DLH data as the basis for allocation of below depot maintenance costs. This is because the ratios of the DLH for the MDS's to the total DLH for the command/base would be relatively unaffected by the reporting inaccuracies. (A more detailed evaluation of the impact on WSSC data accuracy implied by the findings of the field investigation of maintenance direct labor hour data is given in Volume IV [5] of this series of reports.)

D. COMMAND AND GEOGRAPHIC LOCATION COVERAGE

WSSC computes costs only for those aircraft which are owned by organizations within the seven so-called "relevant" major commands: Alaskan Air Command (AAC), USAF Europe (AFE), Military Air Training Command (ATC), Military Airlift Command (MAC), Pacific Air Force (PAC), Strategic Air Command (SAC), and Tactical Air Command (TAC). It should be noted that these seven commands have approximately 60% of the aircraft in the Air Force and log about 80% of the flying hours. As a consequence, the costs associated with a sizable fraction of the aircraft in the Air Force are not currently represented in WSSC.

Most of the aircraft not included in the WSSC system are owned by Logistics Command (LOG), Systems Command (SYS), USAF Reserve (AFR), and Air National Guard (ANG) commands. LOG and SYS aircraft are largely engaged in nontypical activity (i.e., used as test or collection

platforms) or are few-of-a-kind MDS's, while some of the aircraft owned by AFR and ANG tend to be of older vintage and have become largely unique to these commands. Also, the data required by WSSC in order to provide adequate cost visibility tends to be less readily available from guard and reserve data channels.

It thus is understandable that the WSSC system currently excludes data for LOG, SYS, AFR and ANG aircraft. However, Desmatics recommends that future consideration be given by VAMOSC to extending WSSC coverage so that it includes at least some types of aircraft from these four commands, particularly those MDS's which also occur in the seven relevant commands.

While WSSC currently limits consideration to aircraft within relevant commands, it also obtains certain types of input data from LOG, SYS, and CSV (Communications Command). Logistics Command operates the Air Logistics Centers (ALC) which provide depot maintenance and supply support for aircraft. CSV provides base level communication which constitutes part of the installation support provided for aircraft. Systems Command is sometimes the host command at bases where relevant command aircraft are stationed, and thus is the source for installation support cost data for those bases.

There is an indication that some of the installation support which should be assessed against aircraft may be found in the ABDS and MPC files for the Electronic Security Command (ELC). For example, in FY81, Kelly AFB was observed to have an abnormally low amount of installation support cost in the LOG command ABDS files. However, at Kelly the ELC has extensive activities whose personnel counts may not be included in the base population figures WSSC uses, but whose installation support

costs are included in the LOG cost files. The Kelly discrepancy is also affected by the existence of the San Antonio Real Property Maintenance Agency (SARPMA) which centrally funds RPM for facilities in that area.

In another example, the USAF Academy has aircraft which are reported in WSSC, but since the Academy is a separate operating agency and its cost data is not input to WSSC, the expenses for installation support which WSSC assigns to Academy aircraft are understated. For a third example, Eglin AFB actually has four separate geographic location (GELOC) codes assigned. Two of these have relevant command (MAC and TAC) aircraft, while the other two have no relevant command aircraft. Thus, if some of the installation support costs for Eglin are reported in the ABDS files for commands which are not input to WSSC, or if they are reported against GELOC's which have no relevant command aircraft, then the installation support costs for the relevant command aircraft will be understated. The Eglin problem is further complicated by the fact that one of these GELOC's (FTEV) is referred to in the AVISURS system as Eglin 9, while elsewhere it is called Hurlburt AFB.

E. CODE USAGE IN ABDS DATA

Much of the cost data used by WSSC is derived from the Accounting and Budget Distribution System (ABDS) through the H069R system. Desmatics has examined samples of such data, including the FY81 data input to VAMOH from MAC, SAC and TAC in VAMOH format C-25 and the entire FY81 WSSC ASO Extract file in VAMOH format C-30.

Using the MAC, SAC and TAC data as input, Desmatics reproduced the VAMOH program logic as described in the system specifications and noted

the types of records which were selected and the way each was classified. Records are treated as unit operations or maintenance if they have certain specified cost center (CC) codes; they are classified as installation support if they have specified program element codes (PEC's). It might be expected that these two classification criteria are mutually exclusive, i.e., that a record having an installation support PEC would not simultaneously have an operations or maintenance CC code. However, it was found that such combinations occurred frequently in the samples examined by Desmatics. For convenience of discussion, these cases will be referred to as "conflicts." This is not to imply that such combinations are invalid, only that they seemed to be ambiguous (i.e., subject to more than one interpretation) with respect to the classification logic described in the VAMOH specifications.

VAMOH programs perform classification of ABDS records by means of a sequence of independent filtering operations. Originally the check of PEC was performed before the CC code was tested, with the result that ambiguously coded records were classified as installation support. The conflicts encountered in the Desmatics tests were called to the attention of the Office of VAMOSC, and the program logic was subsequently changed so that CC's are now checked first. This logic sequence causes ambiguously coded ABDS records to be treated as operations or maintenance, rather than installation support.

Desmatics subsequently performed a more comprehensive examination of ABDS data using the FY81 WSSC ASO Extract File (Format C-30) consisting of 182,319 records from several commands. Again the VAMOH selection and classification logic was reproduced, and all records with conflicting codes were flagged and summarized. Since the vast majority of conflicts

were found to involve BOS rather than COM or RPM, the following discussion is limited to analysis of BOS-type conflicts.

Maintenance conflicts (records having a maintenance CC and a BOS PEC) were found to occur in all relevant commands and for all types of maintenance cost centers. An examination of the EEIC's of these records show that labor, materials, contract and other types of expenditures were all represented.

It had been suggested that maintenance conflicts primarily represent the maintenance of transient aircraft, which commonly is coded with a BOS (XXX96) PEC code. The Desmatics analysis confirms this to be the case for records having a CC of 225X (Base Flight and Transient Aircraft Maintenance). However, this accounts for only a fraction of the maintenance conflicts encountered in the data, both in terms of the number of records and the dollar amounts involved. It is, of course, possible that the maintenance conflicts which were observed in cost centers other than 225X may also represent costs for maintenance of transient aircraft; however, Desmatics has not been able to obtain an authoritative explanation for these expenses.

One additional comment is warranted with respect to maintenance conflicts. It was observed that some accounts had a substantial year-end negative balance for FY81. The largest of these were four PAF accounts at Hickam AFB which had a cost center code of 2309 (23XX is listed in AFR 170-5 [12] as Field Maintenance Squadron) with EEIC's of 605, 609, 641 and 693, and total over one million dollars. The descriptions for EEIC's 605 and 609 indicate that they cover issues and turn-ins, so it is conceivable that turn-ins might exceed issues for a particular year, but it would be worth investigating further to determine

whether large negative year-end balances are valid. They are subsequently netted out by larger positive balances in other accounts having the same CC code, so their presence is generally obscured.

The Desmatics examination of unit operations conflicts produced results similar to those for maintenance, except that there were far fewer cost accounts with negative year-end FY81 balances. Here again, conflicts were found in all relevant commands (except AAC), and for all the CC codes which are used to define unit operations. Accounts with conflicting codes were found for military and civilian direct labor, material costs, contract costs and a variety of other expenditures. Among the operations conflicts having substantial FY81 year-end balances were 1322 (MAC life support), 130K, 130L, 130M (TAC wing operations (unique functions)) and 3700 (largely host-financed support of ATC field teams).

The WSSC specification calls for all operations costs (RC/CC XX13XX), except for disaster preparedness (XX1311) and chemical/biological warfare (XX1312), to be included in the command staff category of unit operations. It is Desmatics' opinion that these two excepted categories should be included in installation support. An examination of 1981 ABDS data indicates that while the majority of disaster preparedness costs were assigned a BOS PEC code, a considerable amount (including over $160,000 in airman pay at one base) was otherwise coded and would not be picked up as BOS. On the other hand, the majority of chemical/biological defense costs were not assigned a BOS PEC code, so most of these support costs would be excluded from WSSC entirely.

Except for Below Depot Maintenance and Installation Support, WSSC specifications call for exclusion from unit operations of all ABDS costs

having EEIC codes of 601XX (aviation POL), 602XX (packaged aviation oils), 603XX (missile propellants), 604XX (medical-dental division), 614XX (medical-dental supplies), 624XX (medical-dental equipment--stock fund), 634XX (medical-dental equipment--non-stock fund). Although Desmatics did not expect to find an EEIC of 602XX (package aviation oils) associated with a PEC of XXX96 (BOS), several bases used this code combination. The dollar amounts, however, were generally small.

One might expect all medical-dental costs to carry an RC/CC of XX5XXX (fixed military medical and dental treatment facilities). However, Desmatics found several records with 6X4XX which did not have a medical/dental RC/CC. In fact, several 604XX records were noticed which also had a PEC of XXX96 (BOS), in conjunction with an RC/CC of XX3000 (aircraft mission) rather than XX5XXX (medical/dental).

As discussed at length in Volume VI [17], WSSC employs a cost factor, based on data from the Surgeon General, to determine the cost of medical care provided to active duty military personnel in support of aircraft operations. WSSC largely avoids duplicating these costs by omitting ABDS costs which have a medical/dental RC/CC code. However, cost records having a medical/dental EEIC without a medical/dental RC/CC may possibly represent duplication of costs unless it is determined that these are legitimate additional medical expenses not covered by the Surgeon General's factor.

The previous examples indicate that some cost records encountered in the 1981 ABDS data seem to represent inconsistent or conflicting combinations of codes. In some instances the dollar amounts are trivial, while in other cases they are quite considerable. In those situations where the potential impact is significant, it would be feasible to

change the WSSC or VAMOH logic to select (or reject) specific codes at a more detailed level. For example, it would be better in Desmatics' opinion to select records having an RC/CC of XX1311 or XX1312 for specific inclusion in BOS, regardless of which PEC was assigned. This would prevent the omission of disaster preparedness and chemical biological defense costs for those instances in which a PEC of XXX96 was not assigned.

F. CODE USAGE IN MPC DATA

WSSC uses data from the E300Z Advanced Personnel Data System (commonly referred to as the MPC system) as its source of manpower information. MPC records are primarily identified by GELOC, CMD and PEC codes, which correspond with similar codes in the ABDS cost files. In addition, MPC uses Functional Account Codes (FAC) which correspond closely but not identically with the RC/CC codes used in ABDS.

Desmatics examined a large (over 75,000 records) sample of FY81 MPC data to observe the consistency of code usage. It was found that, like the ABDS situation, there were a number of instances in which records having installation support PEC codes also had unit operations or below depot maintenance FAC codes. However there were far fewer instances in the MPC data than were found in ABDS.

During its examination of personnel data, Desmatics noted instances of personnel whose inclusion in WSSC input is at least questionable: those reported with a PEC of 02002 (Foreign Military Sales) or 28030 (War Readiness Materiel - Ammunition). At first glance it would seem that FMS and WRM are not pertinent to WSSC. However it was determined that many of the FMS personnel are in aircraft operations or maintenance

FAC codes and are probably associated with aircraft, such as the E3A, F5 and F16, sold to foreign governments. Presumably the FMS personnel in the E300Z files, several of whom were observed at Tinker AFB, Vance AFB, Williams AFB and others, were providing support for the E3A, F5 and F16 foreign sales and training programs. Based on their DAFSC's, some of the FMS personnel at Tinker are associated with TAC AWACS activity, but since they were assigned to ATC, which has no E3A aircraft, they (and their associated costs) will not be linked to the TAC aircraft they support.

VI. CONCLUSIONS, RECOMMENDATIONS, AND OFFICE OF VAMOSC COMMENTS

This volume has provided a brief description of the WSSC subsystem of VAMOSC and has described the scope of the Desmatics, Inc. study effort. In addition, this report has examined, from the standpoint of face validity, those WSSC allocations based on flying operations data and has assessed the quality of WSSC input data.

A. SUMMARY

In its examination of the data, Desmatics has observed that there are conflicting combinations of codes (e.g., PEC, RC/CC, EEIC) used in the reporting of cost and manpower data. As a result, the way in which certain costs will be classified depends on which type of code is allowed to predominate. There may well be justification for modifying the logic used to select and classify various types of costs in order to resolve conflicts.

With respect to the flying operations ratios, which are used extensively by WSSC for allocation of various types of costs, it was found that the form of ratio currently used by WSSC produces inconsistent results, in the sense that the relationship between the costs allocated to two MDS's is not independent of the cost allocated to other MDS's. This problem can be solved by substituting a consistent form of ratio (also involving flying hours and possessed hours), which is discussed.

It was also observed that the application of a single-stage allocation process produces different results than are achieved using a two-stage process based on a relevant/all ratio. The differences

obtained by the two methods tend to be of relatively small magnitude in percentage terms, but may represent fairly sizable sums in absolute terms. This situation does not occur if the consistent form of allocation is used.

B. RECOMMENDATIONS AND REPLIES

Reports [3,4,5,6,17] address individual WSSC algorithms and provide specific recommendations for those algorithms. This section lists Desmatics' general conclusions and recommendations, based on its overall evaluation of the WSSC system as a whole. Where appropriate, the responses or comments of the Office of VAMOSC are also included.

1. Use of Flying Operations Ratios

Conclusion: From a mathematical standpoint, the form of the flying operations ratios used in WSSC in FY81 is "inconsistent," in that the cost allocated to one MDS relative to that allocated to another MDS is affected by the presence of other MDS's.

Recommendation: Where possible, the Office of VAMOSC should replace the use of flying operations ratios, for example by using strength ratios instead. Where the use of ratios based on FH and PH is unavoidable, a consistent form of the flying operations ratio should be used. The value of the required parameter, r, should be based on the results of the later part of the current study.

Office of VAMOSC Comments: "Concur. For FY82 processing, two algorithms were changed from allocations using the original 'inconsistent' ratios. These were Aircraft Security and Installation Support. During FY83 or FY84, the Command Staff and Other Unit algorithm will also be changed. The other four applications will be modified when the required parameter, r, is defined and reviewed."

2. Relevant/All Ratios

Conclusion: The relevant/all ratios used in FY81 processing may be computed in either one stage or two stages but the results are not identical, owing to the inconsistency of the flying operations ratio.

Recommendation: The Office of VAMOSC should use a one-stage calculation as described in AFR 400-31, Volume II, throughout WSSC. This calculation should be based on a consistent form of the flying operations ratio.

Office of VAMOSC Comments: "Concur. Implementation planned for FY84 processing."

3. Aircraft System Security Cost Allocation

Conclusion: While security cost allocations in FY81 were based on both FH and PH, these costs seem clearly to be driven solely by inventory factors alone and are not affected by the amount of flying.

Recommendation: The Office of VAMOSC should base the allocation of aircraft system security costs solely on PH ratios.

Office of VAMOSC Comments: "Concur. This change was implemented for FY82 production."

4. Maintenance Manhour Data

Conclusion: While a previous Desmatics study of maintenance manhour data accuracy indicated that there were frequent cases of maintenance jobs not being reported, accompanied by an inflation of the manhours for jobs that were reported, this does not prevent the use of manhour data as a basis for allocation. (See[5].)

Recommendation: The Office of VAMOSC should continue to use manhour data as the basis for allocation of base level aircraft maintenance labor costs to MDS's.

Office of VAMOSC Comments: "Concur."

5. Relevant Command Aircraft

Conclusion: The WSSC data base includes aircraft from only seven major commands which own 60% of the aircraft and do 80% of the flying. The data base is not as representative as it might be, but for use in the DSARC process this limited data base may be more representative of the type of usage for which aircraft are designed.

Recommendation: The Office of VAMOSC should assess the advantages and disadvantages of broadening the coverage provided by WSSC. Consideration should be given to the types of aircraft usage expected in LOG, SYS, AFR and ANG commands.

Office of VAMOSC Comments: "Concur. During FY84, this proposal will be evaluated based upon a survey and planning effort during FY83."

6. Cost Data Base Completeness

Conclusion: Installation support costs may be significantly understated in certain instances due to the fact that some support costs are only available in sources which WSSC does not now use or are not identified by WSSC logic. One example is that some of Kelly AFB costs are reported by SARPMA and some may be in ELC. Also, in certain instances the base support costs may be at one GELOC while some of the personnel and aircraft are at another.

Recommendation: The Office of VAMOSC should check further on the completeness of the cost data base used by WSSC. Bases which should be spot-checked can be identified by noting those having larger or smaller than average support costs relative to the number of supported personnel.

Office of VAMOSC Comments: "Concur. This is expected to be a Phase II and III validation and verification effort to be completed in subsequent contracts."

7. Conflicting or Ambiguous Codes

Conclusion: many cost records in ABDS and manpower records in MPC were found to have combinations of PEC and RC/CC or PEC and FAC codes which seem ambiguous, i.e., the PEC codes indicate that they

are installation support while the RC/CC or FAC codes indicate that they are maintenance or operations. Desmatics has identified and summarized a sizable number of such conflicts.

Recommendation: The Office of VAMOSC should implement further investigation to determine what types of costs or personnel are represented at base level when conflicting codes are used. This will aid in deciding whether the current processing logic treats these records optimally.

Office of VAMOSC Comments: "Concur. A preliminary review of Desmatics' summaries tends to support the original contention that these conflicts are properly classified as maintenance and operations rather than installation support. A more thorough investigation will, however, be accomplished."

8. Negative Year-End Balances

Conclusion: Several instances were discovered in which cost accounts in ABDS files had large negative year-end balances.

Recommendation: The Office of VAMOSC should determine whether large negative year-end balances are valid.

Office of VAMOSC Comments: "Concur. This review will be completed simultaneously with the investigation per Recommendation 7."

9. Disaster Preparedness and Chemical/Biological Defense

Conclusion: WSSC logic specifically excludes these costs and personnel from unit operations. Some of each, because of the coding used, will fall into installation support but some will not.

Recommendation: The Office of VAMOSC should ensure that all of these costs and personnel are treated as installation support. To accomplish this, all should be selected by RC/CC and FAC regardless of PEC.

Office of VAMOSC Comments: "Concur. The accumulation of Disaster Preparedness and Chemical/Biological Defense costs by RC/CC and FAC regardless of PEC is scheduled to begin with FY84 processing."

10. Nonrelevant Personnel and Costs

Conclusion: WSSC currently includes personnel and costs for activities which do not appear to be pertinent to aircraft operations and support. Examples are foreign military sales and war readiness materiel.

Recommendation: The Office of VAMOSC should determine whether personnel and costs for such activities as FMS and WRM should be included in WSSC.

Office of VAMOSC Comments: "Concur. Any decisions to delete either or both cost categories will be withheld pending results of the determination."

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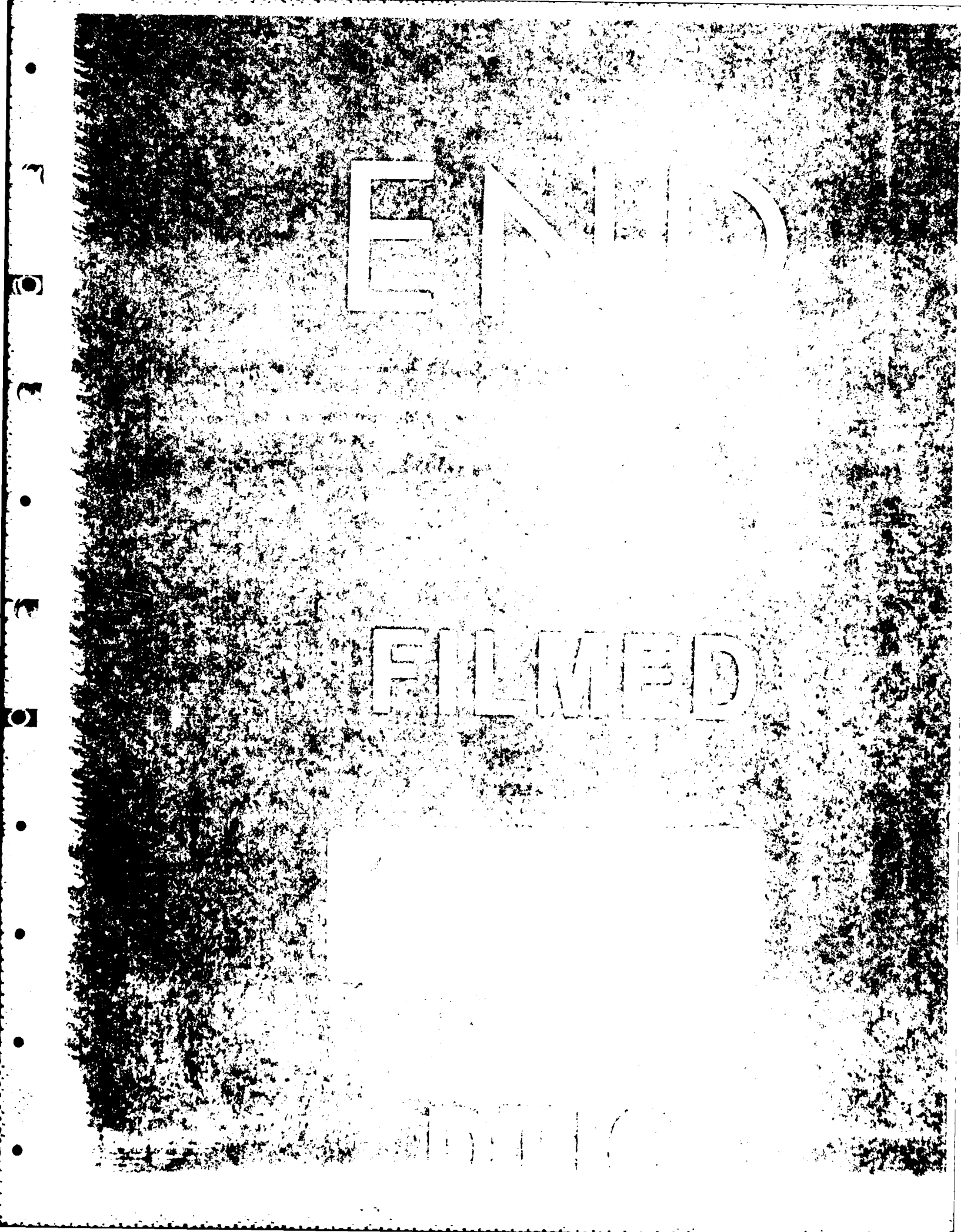
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